Bacteria Total Maximum Daily Load Studies for Hunting Creek, Cameron Run, and Holmes Run

Technical Advisory Committee Meeting
June 30, 2009

Meeting Agenda

- **Introductions and Administrative Updates**
  Katie Conaway, VA Department of Environmental Quality

- **Non-Tidal Source Assessment and HSPF Model**
  Ross Mandel, Interstate Commission on the Potomac River Basin

- **Tidal ELCIRC Model**
  Harry Wang, Virginia Institute of Marine Science

- **Questions**

Why are we here?

- Hunting Creek, Cameron Run, and portions of Holmes Run do not meet the water quality standards recreational use.

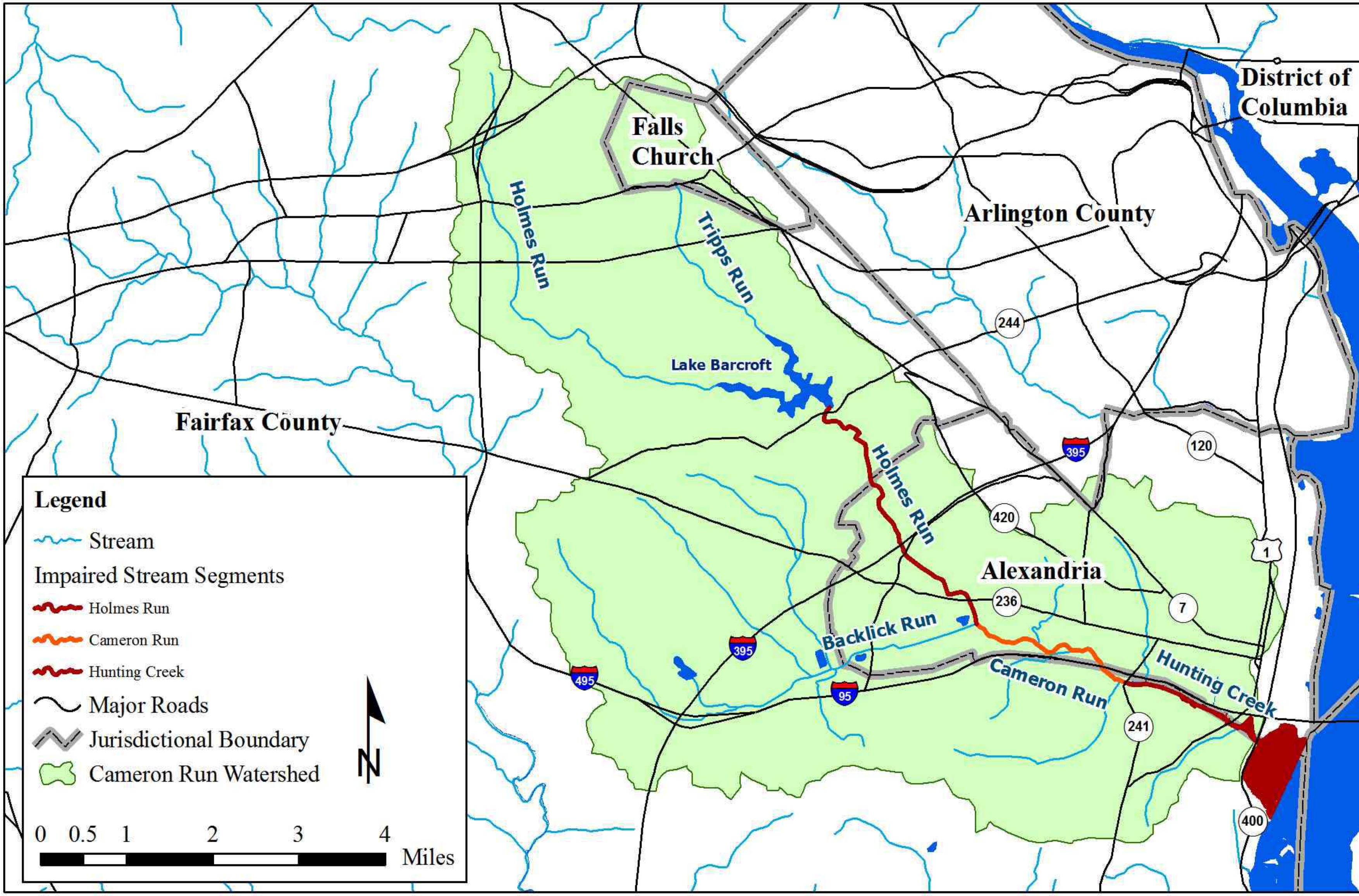
Stream Name	Area	Upstream Limit	Downstream Limit	DEQ Monitoring Stations	Exceedance Rate*
Hunting Creek (Tidal)	0.53 square miles	Route 241 (Telegraph Road) Bridge Crossing	Confluence with the Potomac River	**Station 1aHUT000.01** *(Located at the George Washington Memorial Parkway)*	**11 of 17 samples** *(40.7% exceedance)*
				Station 1aHUT001.72 *(Located at Telegraph Road)*	**3 of 11 samples** *(27.3% exceedance)*
Cameron Run (Non-Tidal)	2.08 miles	Confluence with Backlick Run	Route 241 (Telegraph Road) Bridge Crossing	**Station 1aCAM002.92** *(Located at Eisenhower Avenue)*	**5 of 18 samples** *(27.8% exceedance)*
Holmes Run (Non-Tidal)	3.58 miles	Mouth of Lake Barcroft	Confluence with Backlick Run	**Station 1aHOR001.04** *(Located at Pickett Street)*	**3 of 12 samples** *(25% exceedance)*

- The attainment of the recreational water quality standard use is assessed using E. coli bacteria criteria:

Indicator	Single Sample Maximum (cfu/100mL)	Geometric Mean (cfu/100mL)
E. coli	235	126

** Exceedance rates taken from the 2008 Integrated Assessment, which looked at data from 01/01/2001 to 12/31/2006.*

Location of Impaired Segments



ICPRB Task List

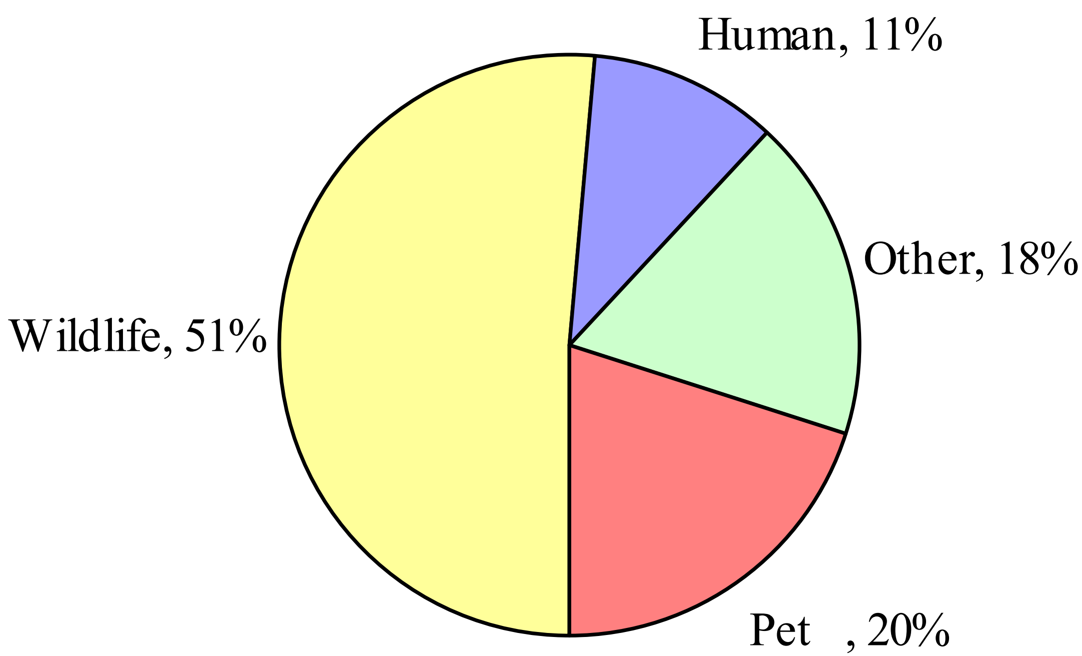
Model Land Use	Completed except for Eastern Tributary
Source Assessment	Completed, except for geese population estimates, CSO and SSO load estimates
Hydrology Calibration	Close to finalized
Bacteria Calibration	Preliminary calibration; finalize with additional data analysis and completed source assessment

Source Assessment

Sources of Bacteria in Hunting Creek/Cameron Run Watershed

- Alexandria CSOs
- Alexandria WWTP
- Non-Point Source/MS4s
  - Wildlife
  - SSOs
  - Septics
  - Pets

Hunting Creek BST Results

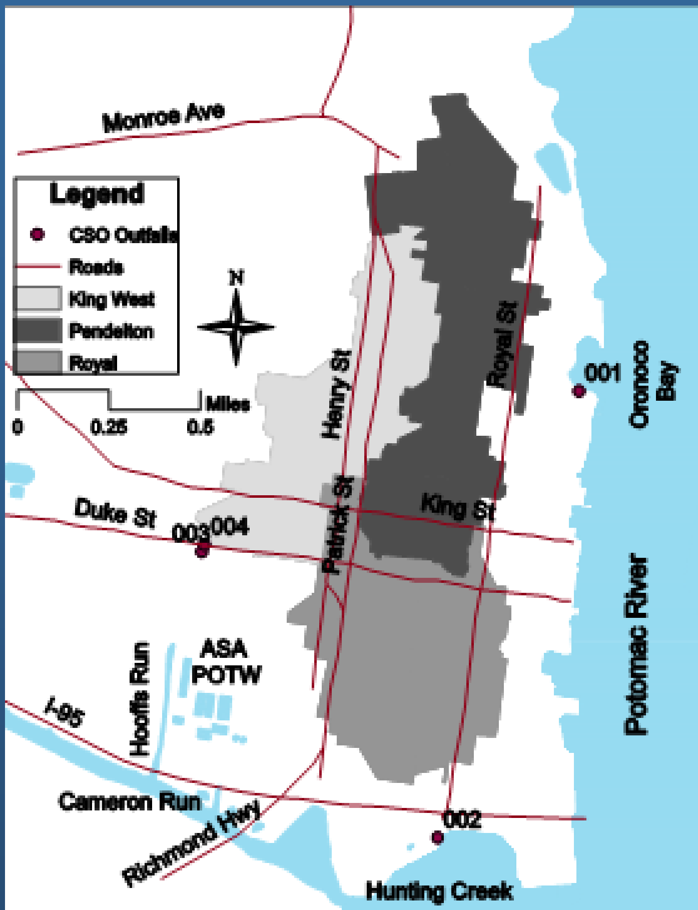


Alexandria WWTP

	Flow (MGD)	Concentration (#/100mL)	
		E. coli[1]	Fecal[2]
Minimum	31	1	1
1st Qtr	34	1	2
Median	37	1	7
Geometric Mean	37	1.2	6.8
3rd Qtr	39	1	19
Maximum	50	6	434

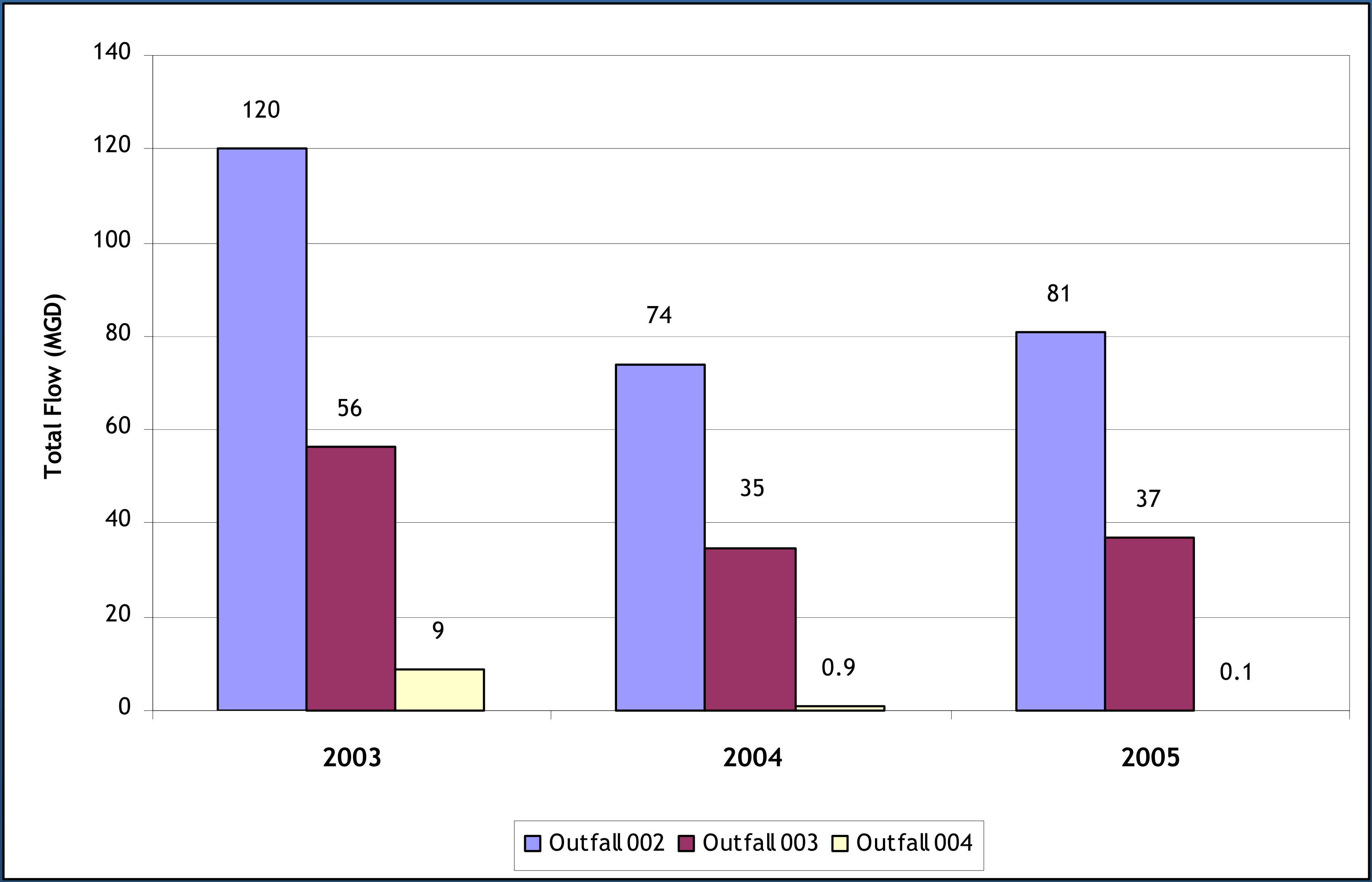
Notes: [1] E. Coli values reported Feb. 2004 through Apr. 2009
[2] Fecal coliform values reported Jan. 2000 through Jan. 2004

CSO Outfalls



Source:
Limno-Tech (2005)
CSO LTCP Modeling Report

Estimated CSO Total Annual Flows
(from Alexandria's CSS SWMM Model)



Monitored CSO Bacteria Concentrations
2002-2004

CSO Outfall	Fecal Coliform (#/ 100 ml)	*E. Coli* (#/ 100 ml)
002	23,000 - 1,600,000	11,100 - 886,000
003	22,700 - 1,600,000	2,330 - 763,000
004	140,000 - 1,600,000	29,500 - 1,720,000

Source: Greeley and Hansen (2006) CSS Permit Project Summary Report

Sanitary Sewer Overflows

- Default Values
  - 1,000 miles of service lines per 250,000 people (Metcalf & Eddy, 1997)
  - 140 SSOs per year per 1,000 miles of service lines (Metcalf & Eddy, 1997)
  - Average overflow volume per SSO is 90,000 gal. (Metcalf & Eddy, 1997)
  - Fecal coliform concentration is 1×10^7 100mL (Center for Watershed Protection, 2002)
- Next Step:
  - Incorporate Local Data

Septic Systems
(Fairfax County Health Department)

- Assumptions:
  - 4 persons per household with septic system
  - Failure rates of 1.7% of systems per year
  - 70 gal. per person per day
  - Coliform concentration $1\text{x}10^7$ per 100 mL
- 221 Septic systems
- 4 Septic system failures per year

Habitat Assumptions

Deer	All land use types
Raccoon	All residential and forest
Geese	Within 300 ft of streams and ponds
Duck	Within 300 ft of streams and ponds
Muskrat	Within 30 ft of streams and ponds
Beaver	Within 150 ft of streams and ponds



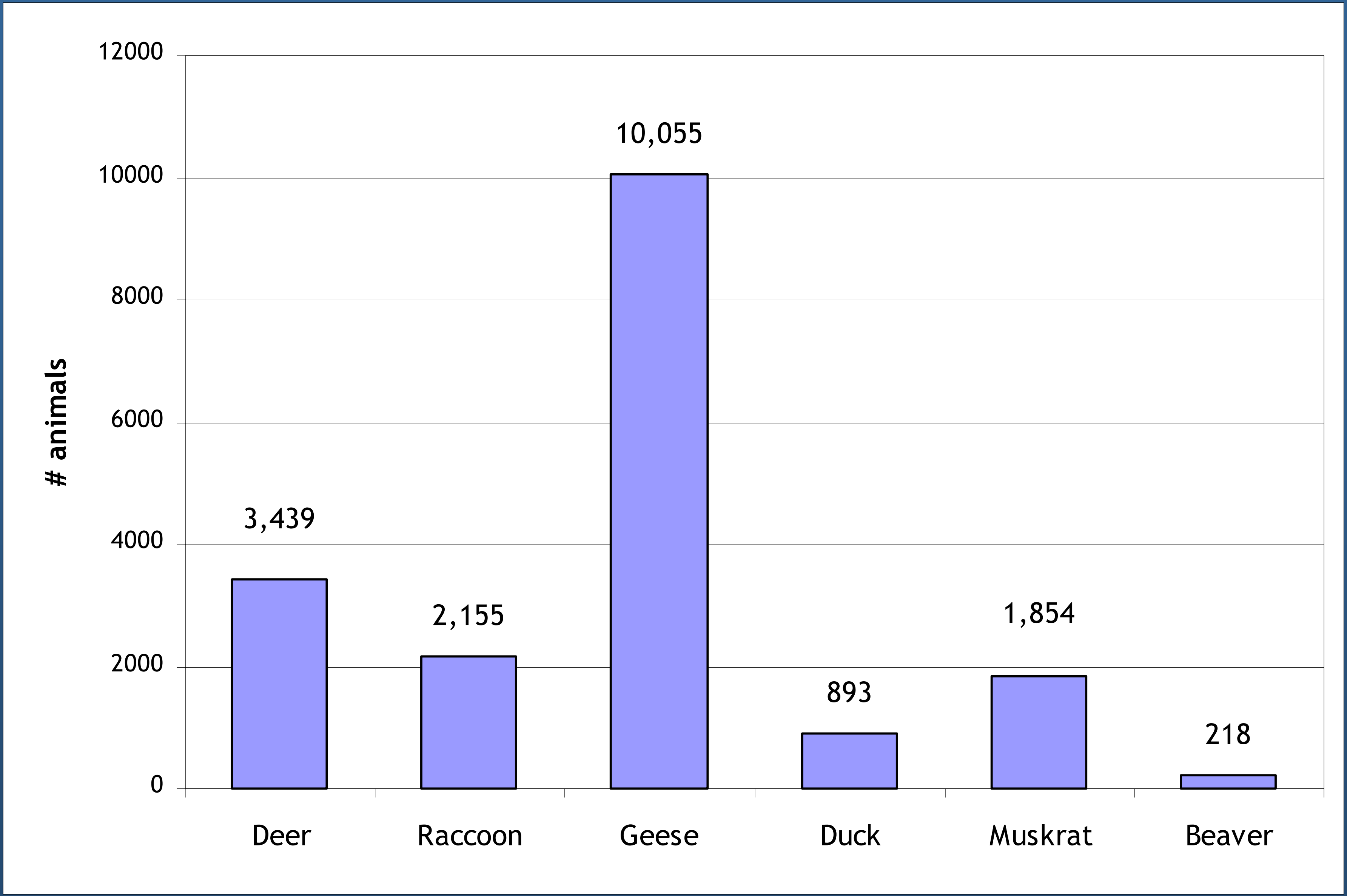
Wildlife Assumptions

(Upper Accotink Creek TMDL, 2007, Michael Fies, VDGIF,2007)

	Population Density (animals/acre of habitat)	Fecal production rate (cfu/animal/day)	Fraction of Day in Stream	% Load on impervious surface
Deer	0.12	2.5E+09	1%	0%
Racoon	0.31	5.0E+09	10%	0%
Goose	2.4	8.0E+08	50%	5%
Duck	0.22	7.5E+09	75%	0%
Muskrat	2.0	2.5E+07	50%	0%
Beaver*	4.8	3.0E+05	90%	0%

* Animal population densities are per acre of habitat except Beaver are per mile of stream or pond edge.

Wildlife Populations



Pets

(Upper Accotink TMDL, 2002,
Neabsco Creek TMDL, 2007)

- Cats – 0.66 per household
  - Total population: 52,497
  - Fecal production rate: 3.0E+08 cfu/animal/day
- Dogs – 0.58 per household
  - Total population: 46,134
  - Fecal production rate: 1.9E+09 cfu/animal/day

Source Assessment: Outstanding Issues

- Size and frequency of SSOs in Cameron Run
- Appropriate method (mean, geometric mean, median) for estimating CSO concentrations
- Goose population before Geese Peace
- Deer population in Alexandria

Cameron Run Watershed Model

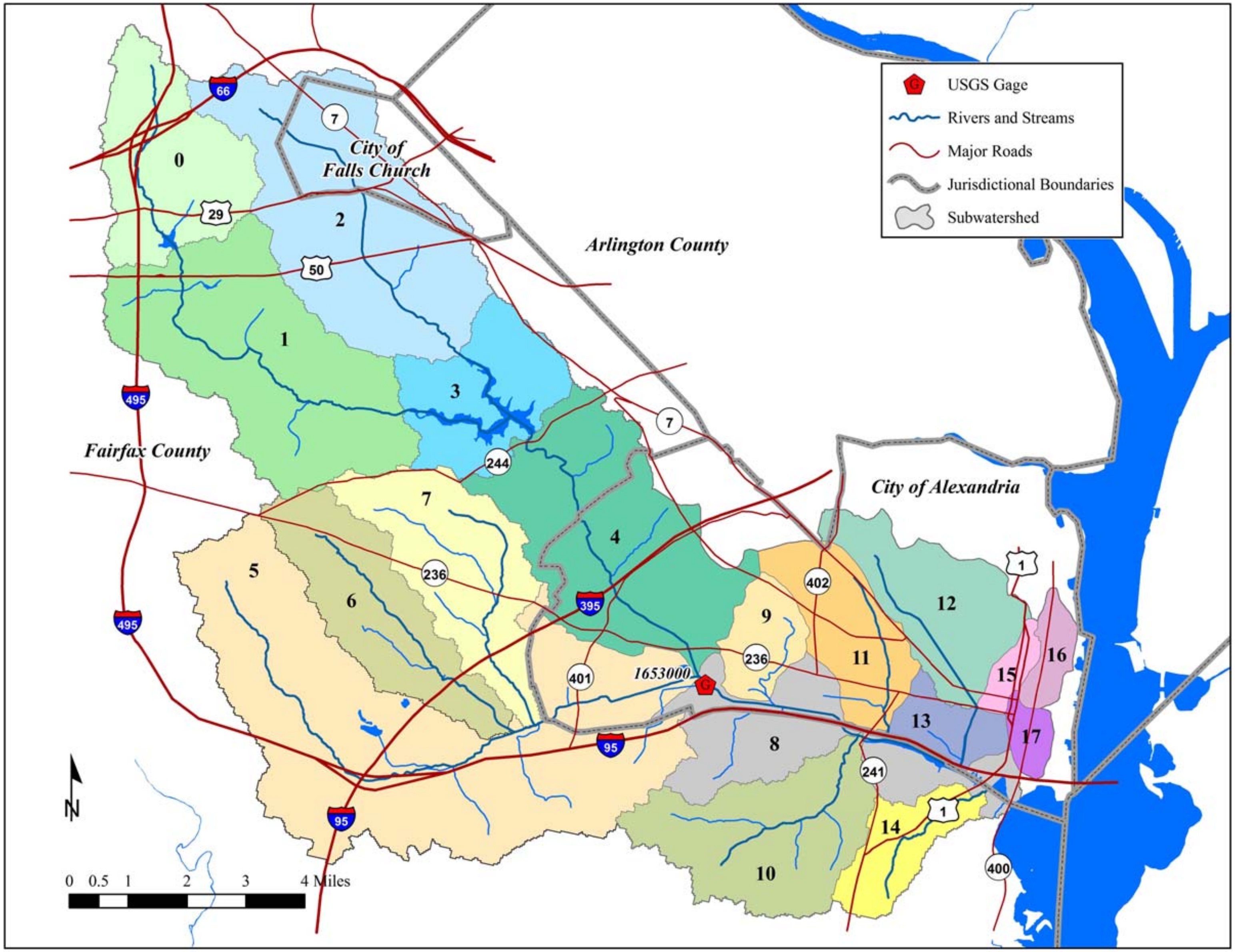
- HSPF model
- Simulation Period: 2001-2005
- Verification Period: 1996-2000
- Meteorological Inputs: Chesapeake Bay Phase 5 Watershed Model
- Land Use: Based on jurisdictional zoning and impervious layers (building footprints, roads, sidewalks, parking lots)

HSPF Model

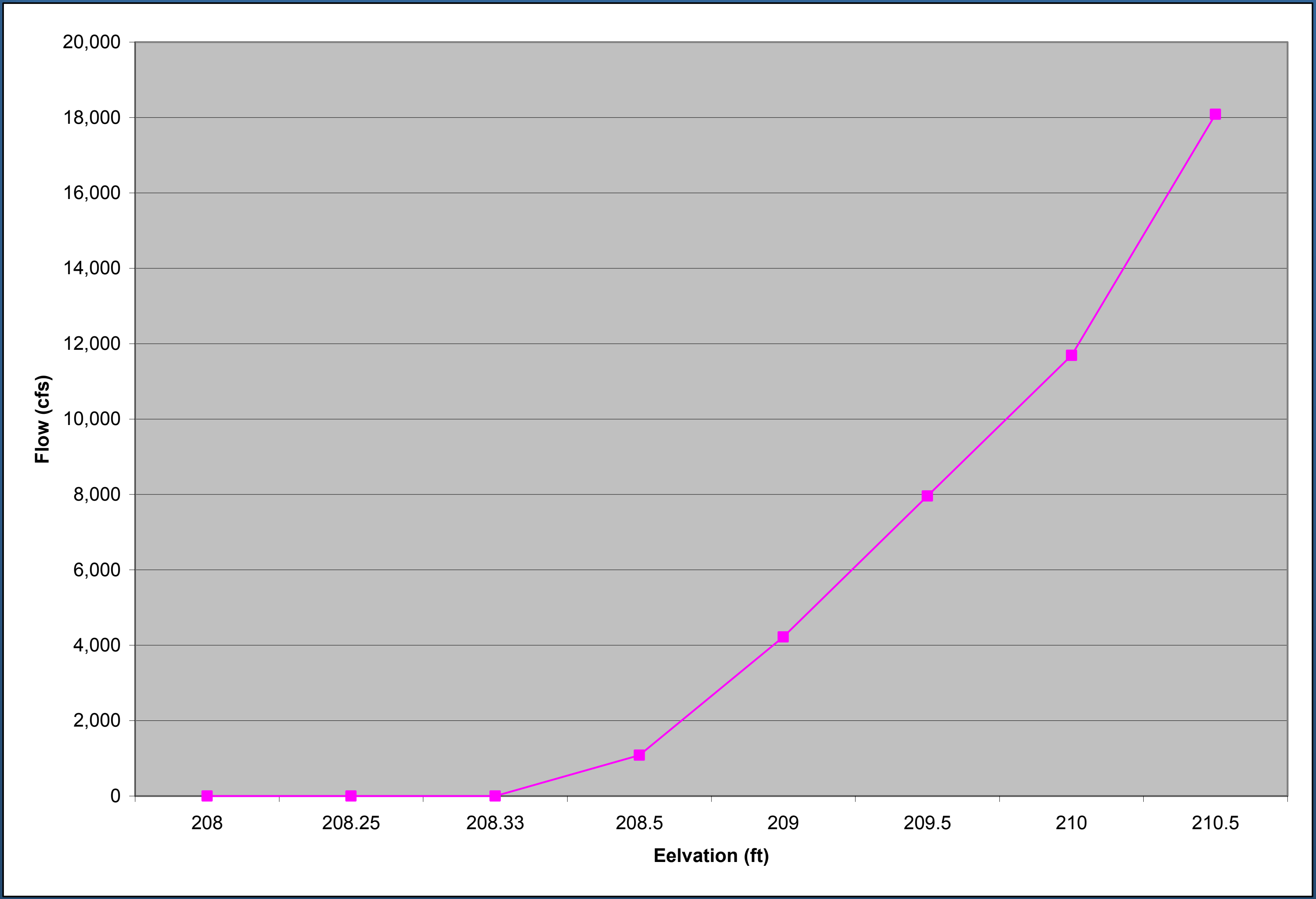
Hydrological Simulation Program Fortran (HSPF)

- Continuous simulation model of hydrology, river routing, and fate and transport of FC bacteria
- Established methodology used in many VA bacteria TMDLS (Four Mile Run, Upper and Lower Accotink Creeks)

Model Segmentation

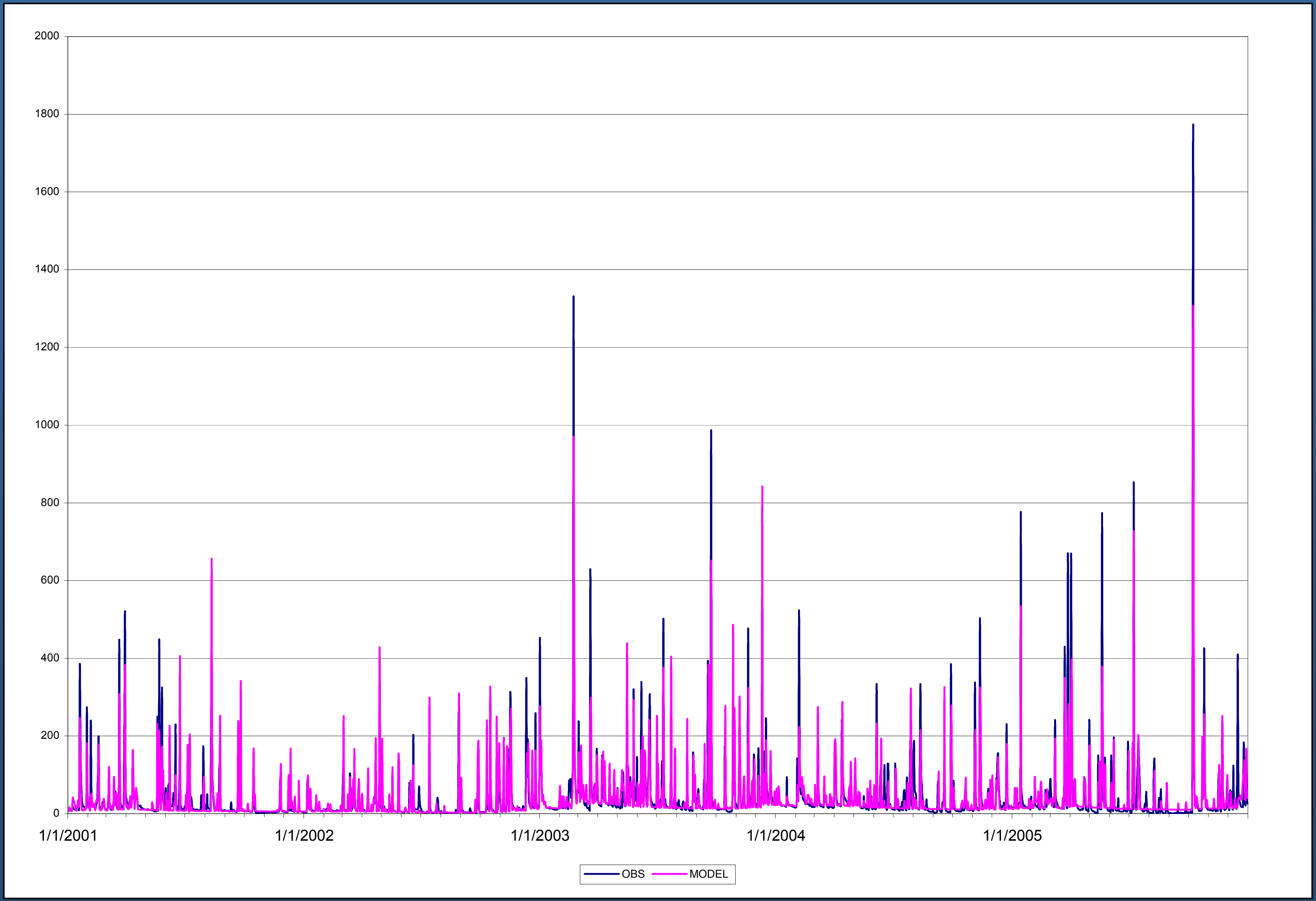


Lake Barcroft: Stage vs. Discharge

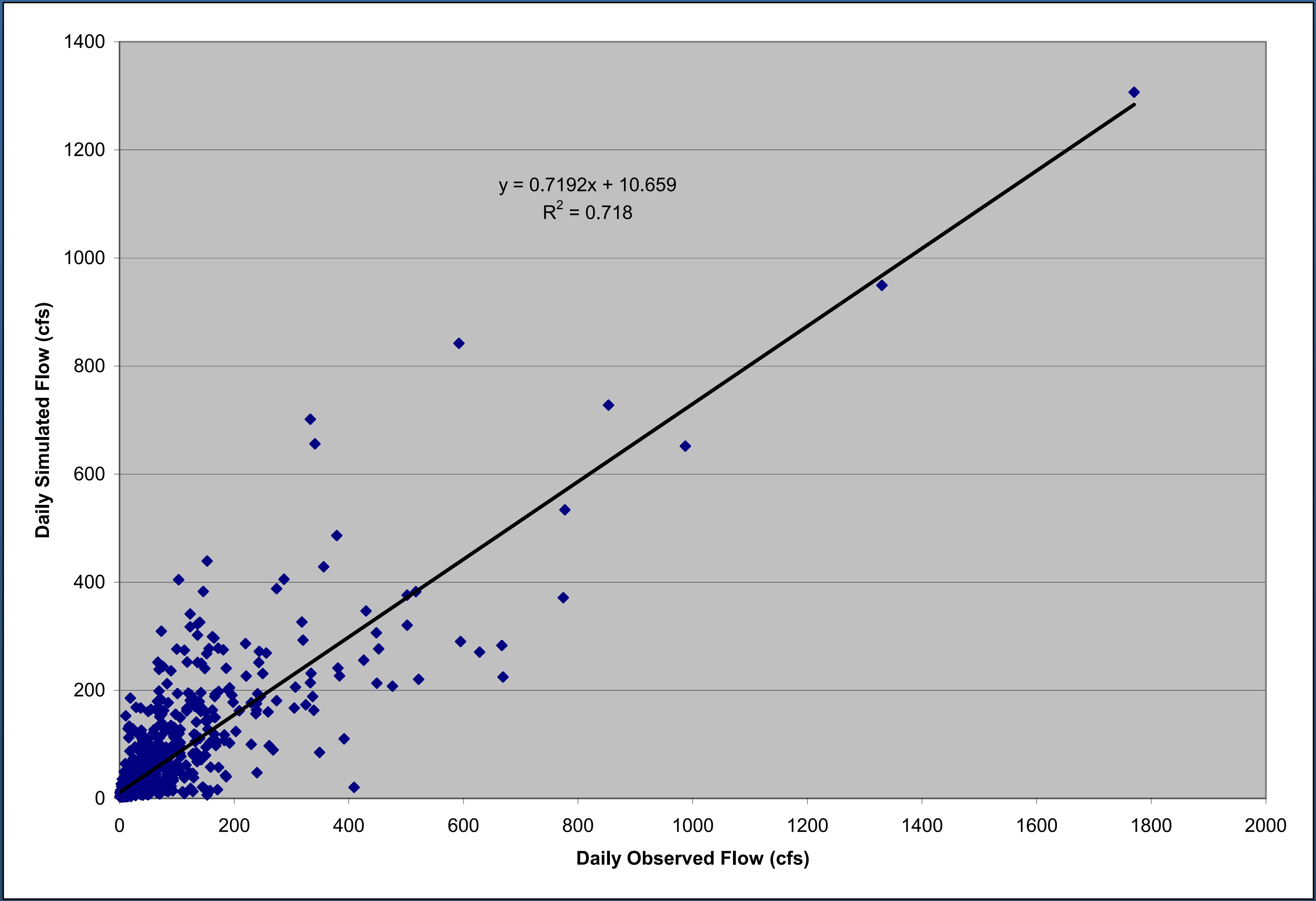


Source: Versar (2007) citing GKY (1993)

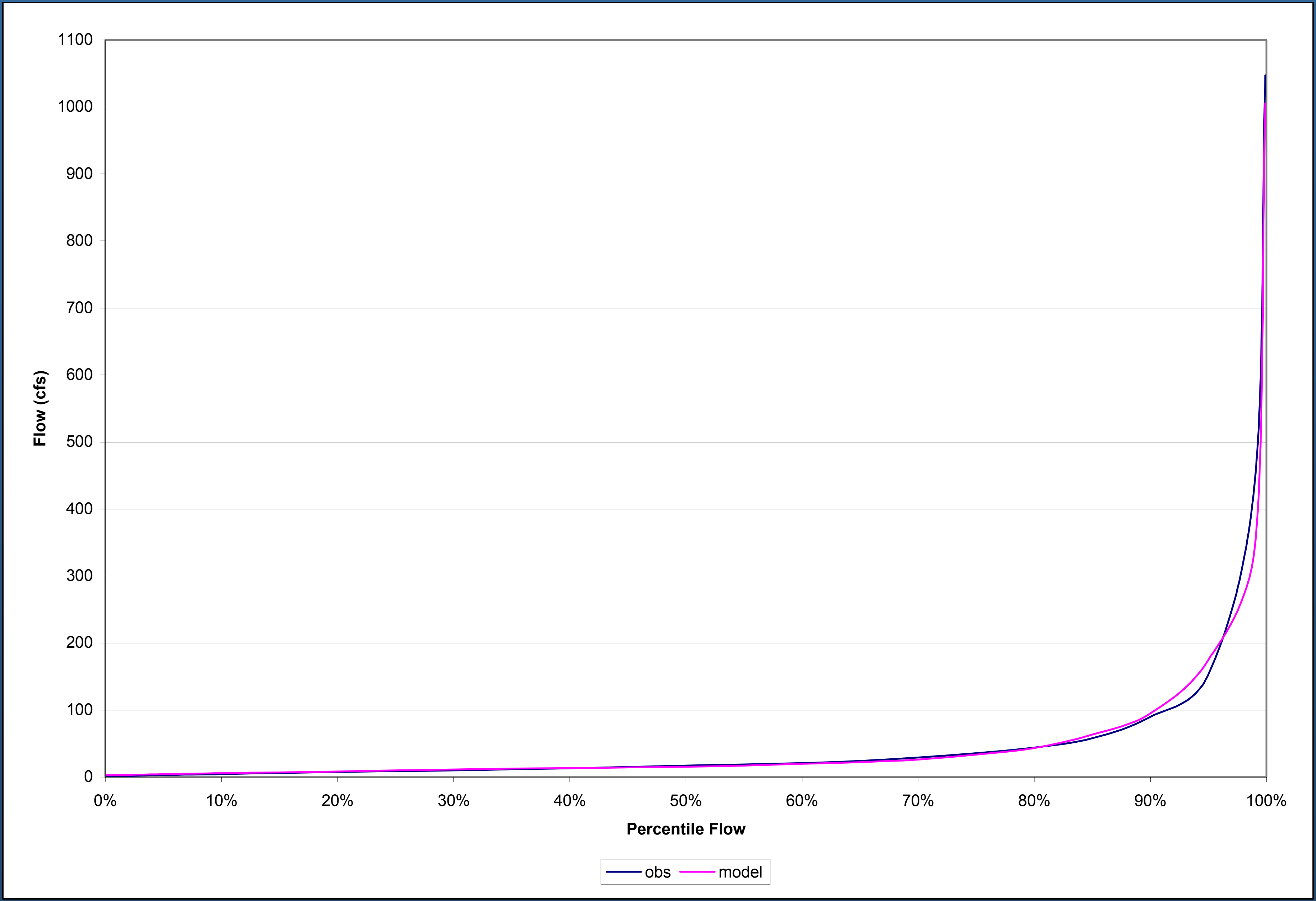
Cameron Run Daily Flow: Simulated vs. Observed



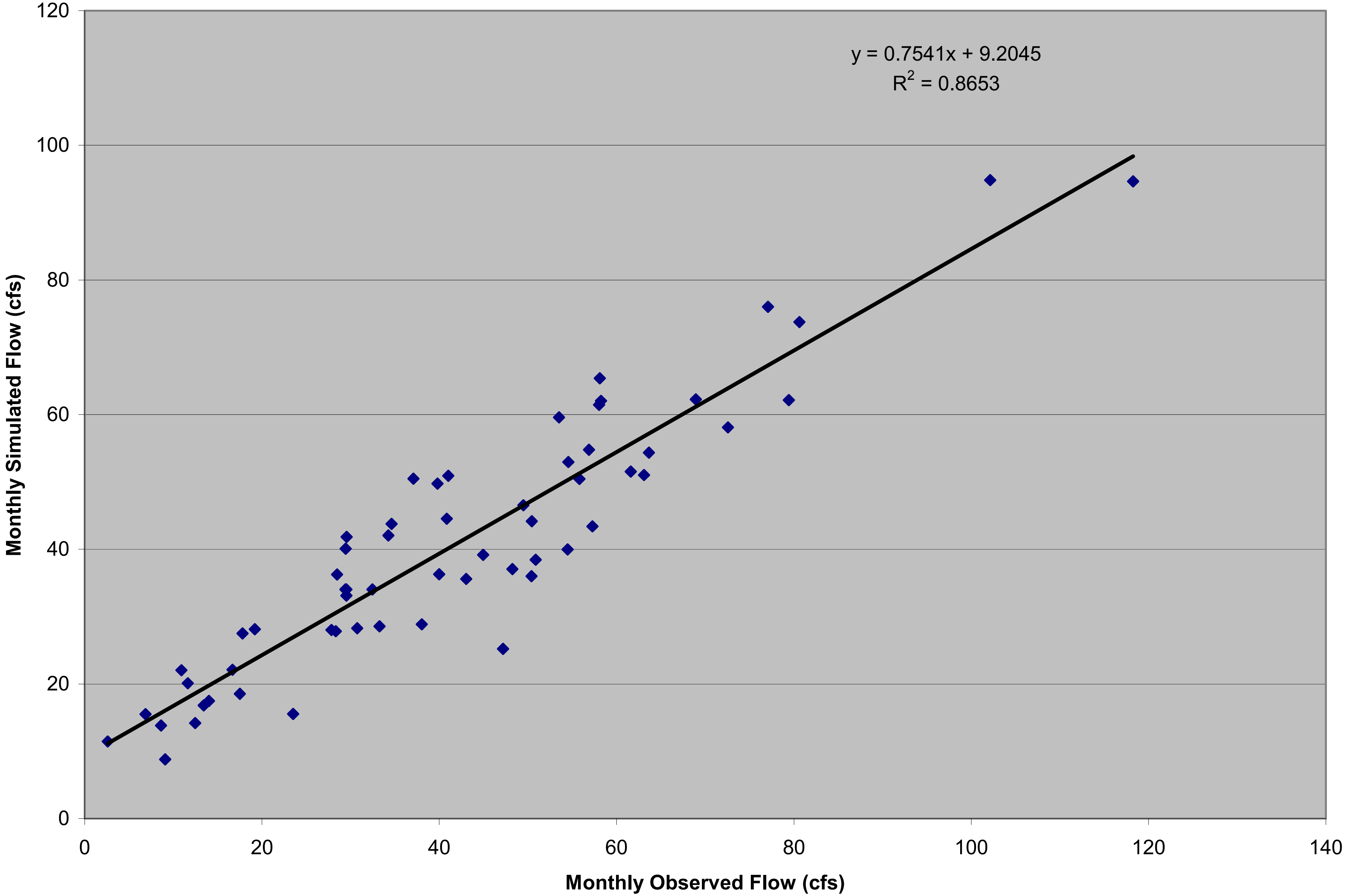
Cameron Run Daily Flow: Simulated vs. Observed



Cameron Run Daily Flow: Simulated vs. Observed



Cameron Run Monthly Flow: Simulated vs. Observed



Relative Error: (Simulated –Observed)/Observed

	Calibration	Verification	Target
Total Flow	-2%	4%	±10%
Low Flow (<50th)	9%	34%	±10%
High Flow (>10th)	-5%	-8%	±15%
Winter Flow	-8%	11%	±10%
Summer Flow	-9%	-10%	±10%

ELCIRC Model for Fecal Coliform Application in Hunting Creek and the Adjacent Potomac River

Harry Wang and Jie Gao

Department of Physical Sciences, School of Marine Science
College of William and Mary
Gloucester Point, VA 23062

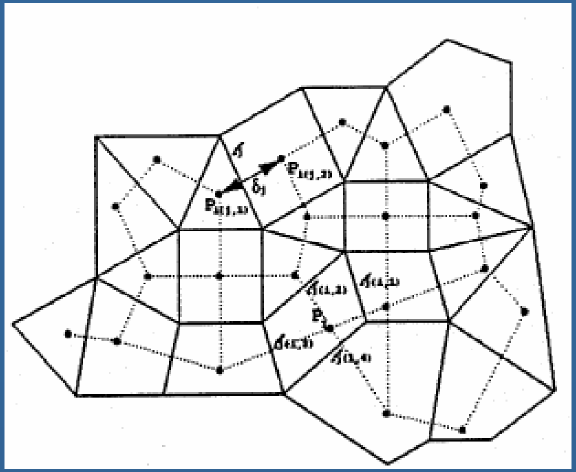
June 2009

Outline

- ELCIRC Model general description
- Set up of ELCIRC model in Hunting Creek and the adjacent Potomac River
- Hydrodynamic model Calibration
- Transport of Fecal Coliform
- Future work

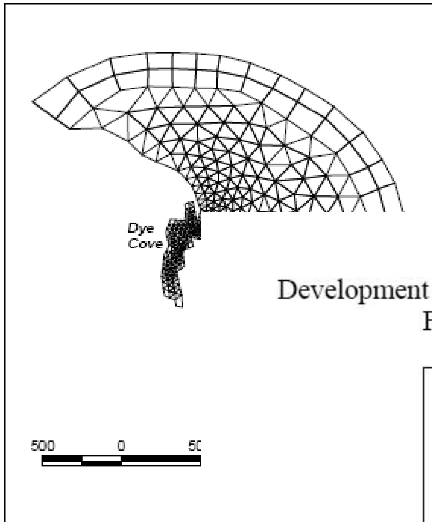
Hydrodynamic Model

http://www.ccalmr.ogi.edu/CORIE/modeling/elcirc/)



- Eulerian-Lagrangian Circulation (ELCIRC) Model
- Orthogonal unstructured grid
- Semi-implicit, finite-difference/finite-volume schemes
- Eulerian-Lagrangian advection scheme (Less restricted by CFL condition)
- Mass conservation transport scheme
- Capable of simulating a wetting-and-drying process.

Identification and Assessment of Water Quality Problems in Mill Dam Creek and Dey Cove Tributaries of Lynnhaven, Virginia Beach



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Yi-Cheng Teng, Ji

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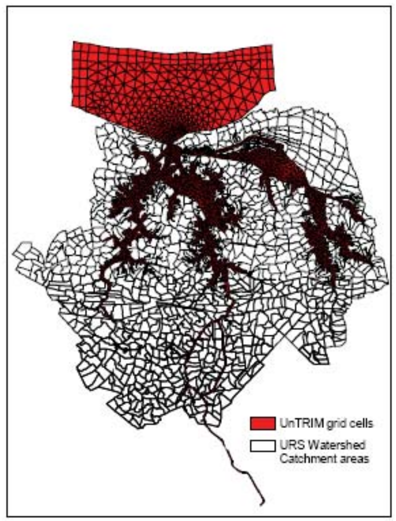
Development of Hydrodynamic and Water Quali
For the Lynnhaven River System



Mac Sisson, Harry Wang, Yuepeng Li, Jian Shen, Albert Ku
Wenping Gong, Mark Brush, and Ken Moore

Draft Report to the
U. S. Army Corps of Engineers, Fort Norfolk Office
and
The City of Virginia Beach

Special Report No. 408
In Applied Marine Science and Ocean Engineering

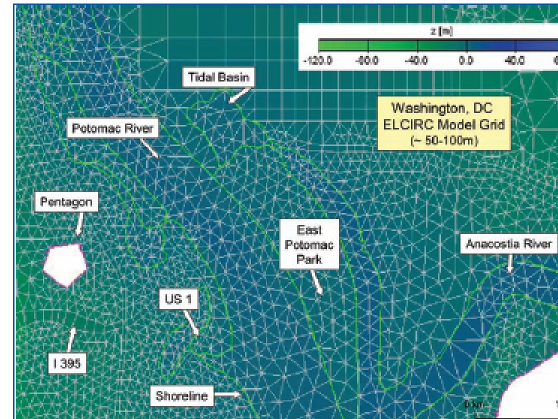
Virginia Institute of Marine Science
Department of Physical Sciences
Gloucester Point, Virginia 23062

March 2009

Predicting the Next Storm Surge Flood

Rapid Prototype Development of a Regional Capability to Address A National Problem

By Barry Stamey
Director of Strategic Collaboration
Noblis Inc.
Falls Church, Virginia
Harry Wang
Associate Professor
Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, Virginia
and
Michael Koterba
Hydrologist
U.S. Geological Survey
Baltimore, Maryland



Unstructured grid delineates water bodies and land areas, including infrastructure details (e.g., major roads) in Washington, D.C., for hydrodynamic model inundation prediction.

On August 29, 2005, hurricane Katrina became the worst natural disaster in the recent history of the United States and was indelibly etched in the memories of its citizens. The costliest and one of the deadliest hurricanes ever, Katrina caused unprecedented devastation. Ocean storm surge, combined with elevated flood water levels in the Mississippi River, led to unprecedented water-level rise in the canal system, which, aided by local winds, eventually topped and then breached the levees.

Katrina underscores a critical consideration in forecast modeling—although atmospheric models predict storm development, movement and intensity, the hydrodynamic modeling capability to predict and visualize flooding remains limited. This is especially relevant when the combined effects of wind-driven ocean storm surges, tides and downriver discharge lead to rapid, intense flooding.

Earlier in the summer of 2005, perhaps serendipitously, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service's (NWS) Sterling, Virginia, Weather Forecast Office (WFO) and Noblis Inc. (formerly Mitretek Systems Inc.) discussed the challenge of predicting Potomac River storm surge and flooding inundation in the metropolitan Washington, D.C., region. Within this area, cities such as Alexandria, Virginia, have experienced flooding related to storm surge, tides and river discharge from tropical storms and nor'easters transiting the Chesapeake Bay.

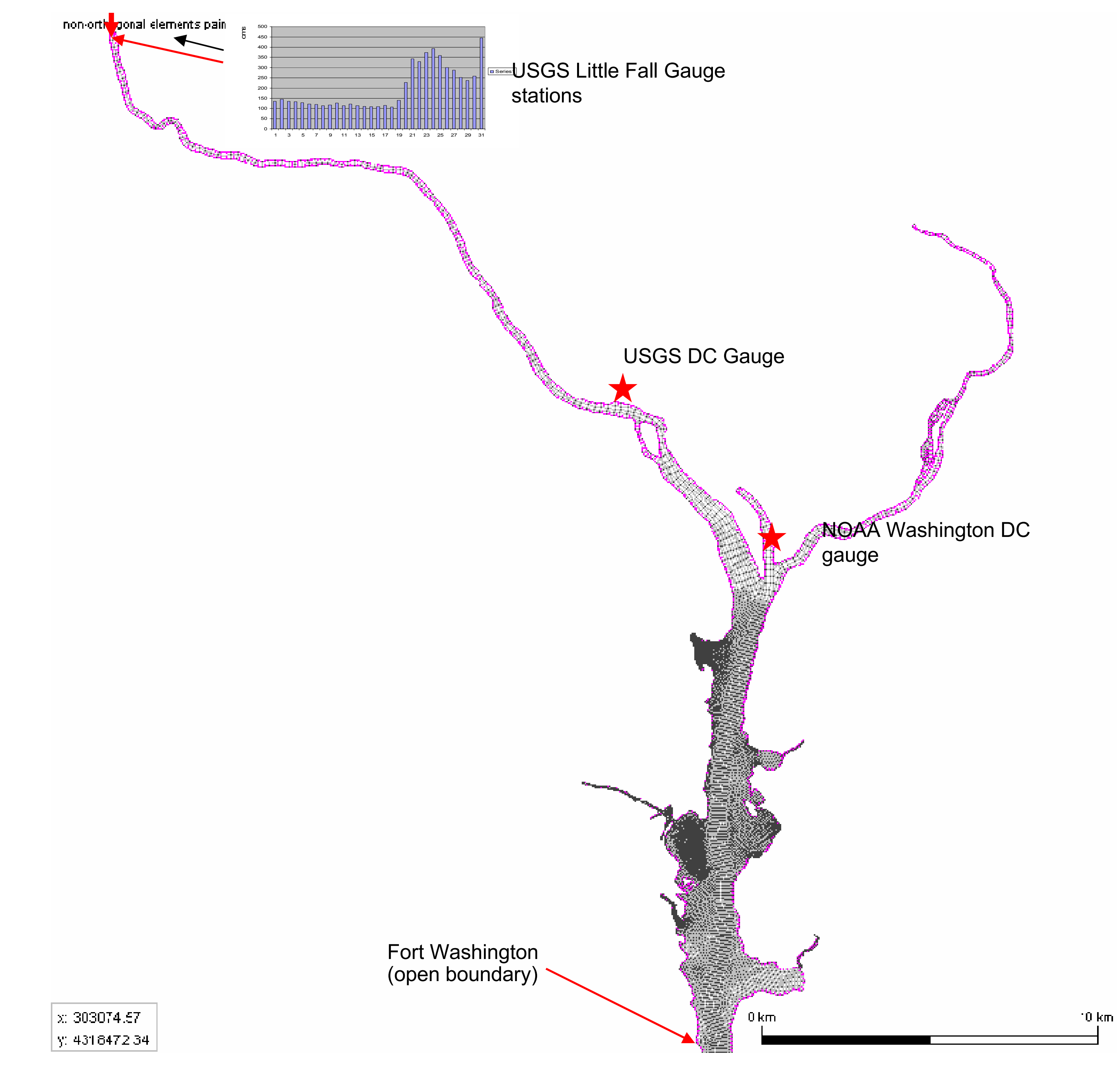
In 2003, hurricane Isabel dumped several inches of rain in the upper Potomac River watershed, and downstream flooding along the river was expected. What was not anticipated was the approximately six to eight-foot storm surge that moved some 120 miles upstream from the Chesapeake Bay. The surge caused significant flooding in Old Town Alexandria and neighboring communities, damaged thousands of homes and businesses and caused losses in the tens of millions of dollars throughout the Chesapeake Bay. It was followed about 48 hours later by downstream flooding that further paralyzed residents for several days.

NWS forecasters currently use a general hydrodynamic model developed in the 1980s to predict tidal gauge water-level heights. Emergency managers (EMs) use this information to estimate what areas will flood, but

Reprinted from **Sea Technology** *magazine.*
For more information about the magazine, visit www.sea-technology.com

Model setup

- Time step: Δt = 3 min (preliminary run for January 2001)
- Horizontal resolution on the order of 50-90 m on the longitudinal and 30 - 50m on the lateral direction in the Hunting Creek and Potomac River
- The model is forced at its open boundary near Fort Washington in the Potomac River with M2, S2, N2, K1 and O1 tidal constituents
- Winds: The wind fields are obtained from Washington DC Airport
- River Discharges at Little Fall USGS gauge daily flow
- Vertical grid resolution 3 meter
- Point and non-point source inputs onto surface layer with prescription of flow rate and concentration


non-orth gonal elements pain
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400
350
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250
200
150
100
50
0
1
3
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11
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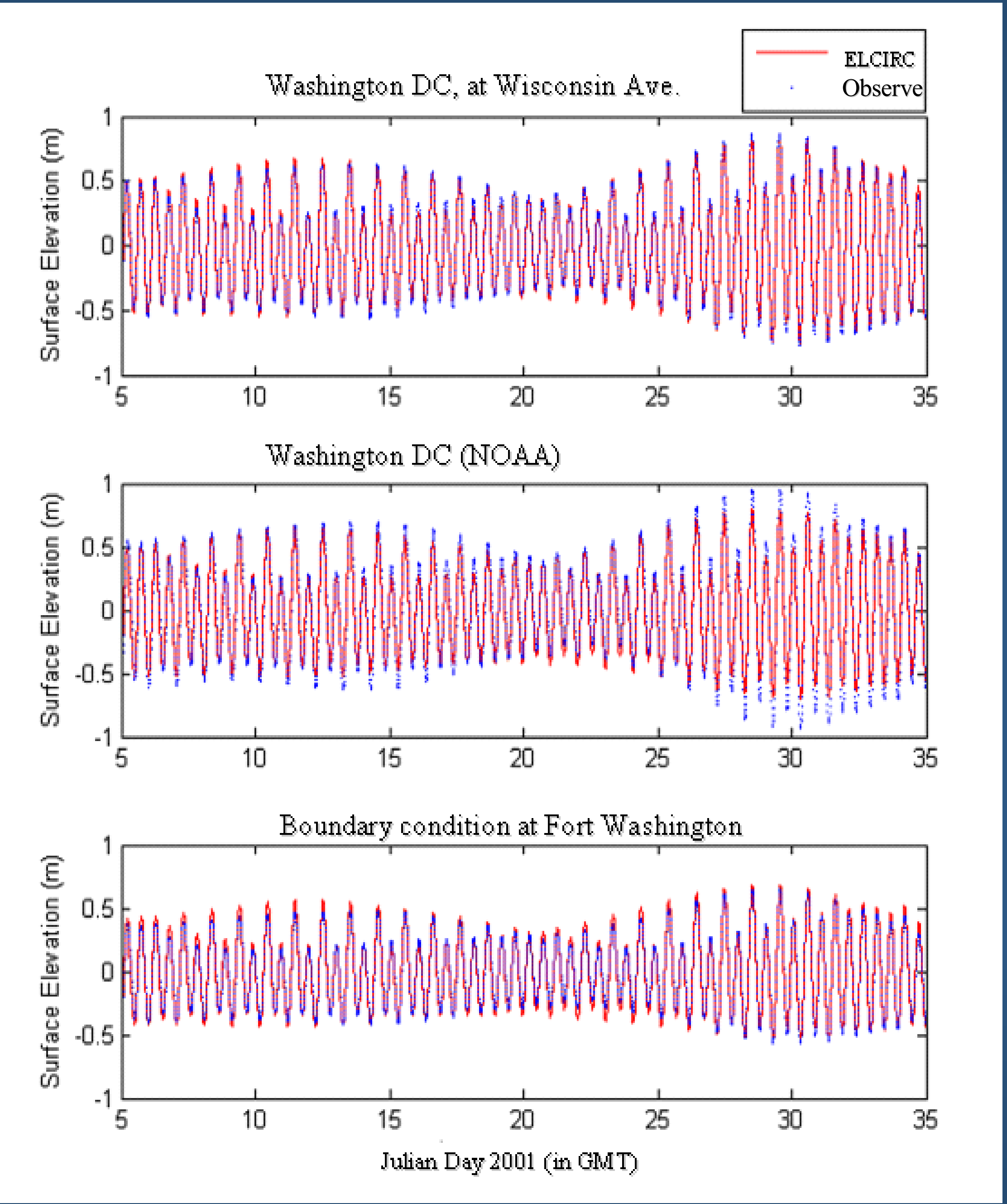
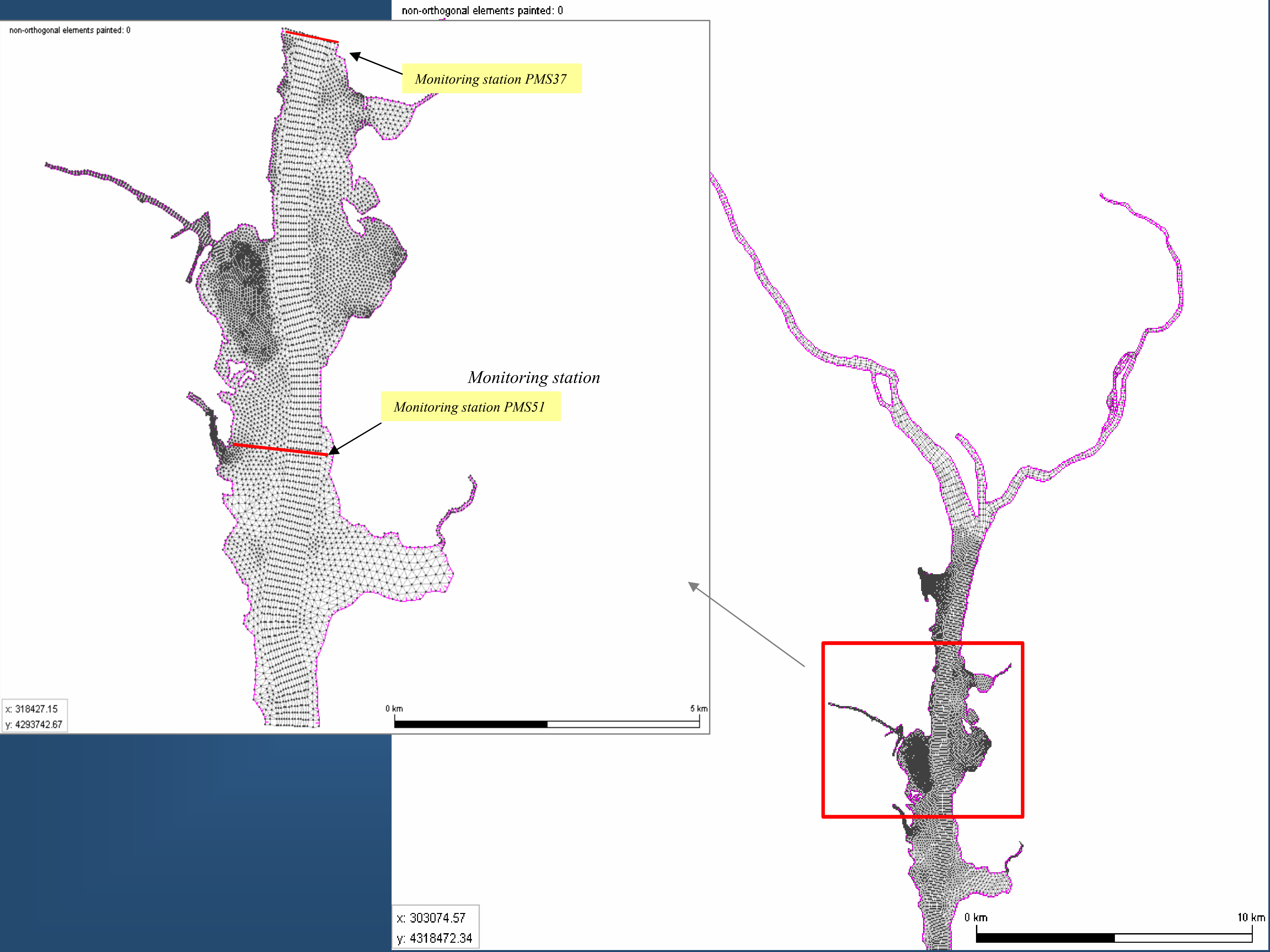
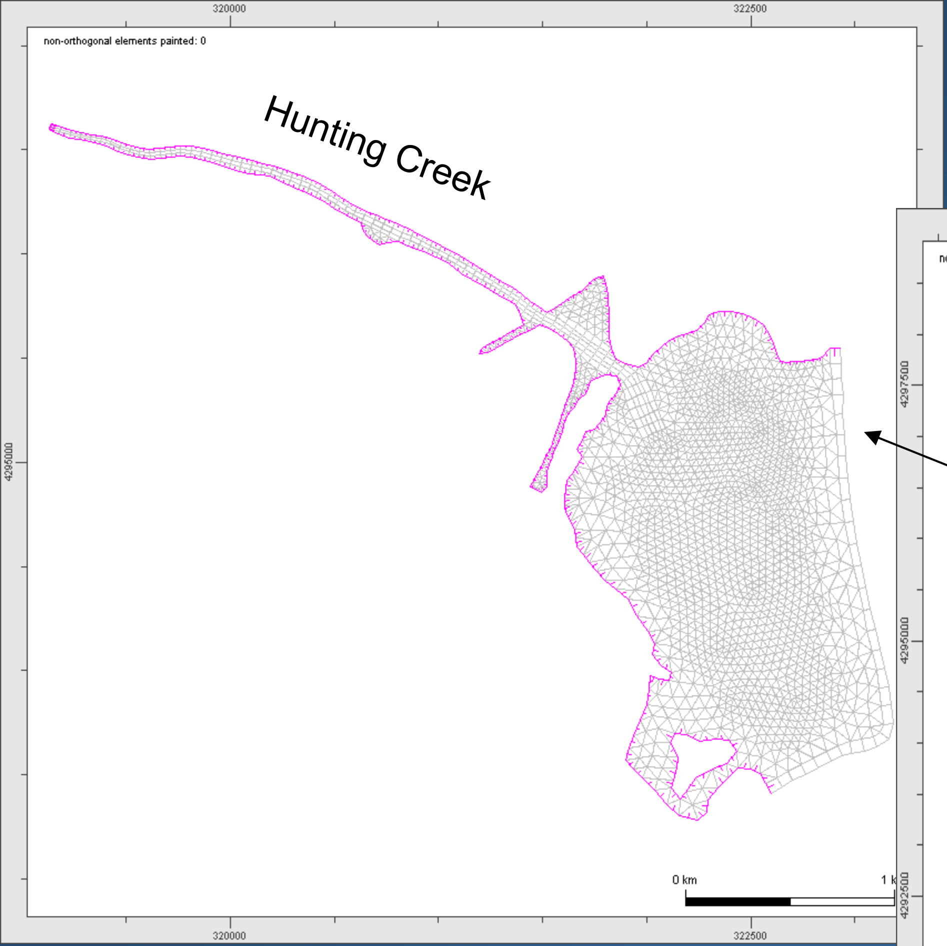
19
21
23
25
27
29
31
Series1
USGS Little Fall Gauge
stations
USGS DC Gauge
NOAA Washington DC
gauge
Fort Washington
(open boundary)
x: 303074.57
y: 4318472.34
0 km
10 km


ELCIRC
Observe
Washington DC, at Wisconsin Ave.
Washington DC (NOAA)
Boundary condition at Fort Washington
Surface Elevation (m)
Julian Day 2001 (in GMT)



non-orthogonal elements painted: 0
non-orthogonal elements painted: 0
Monitoring station PMS37
Monitoring station
Monitoring station PMS51
0 km
5 km
x: 318427.15
y: 4293742.67
0 km
10 km
x: 303074.57
y: 4318472.34


non-orthogonal elements painted: 0
Hunting Creek
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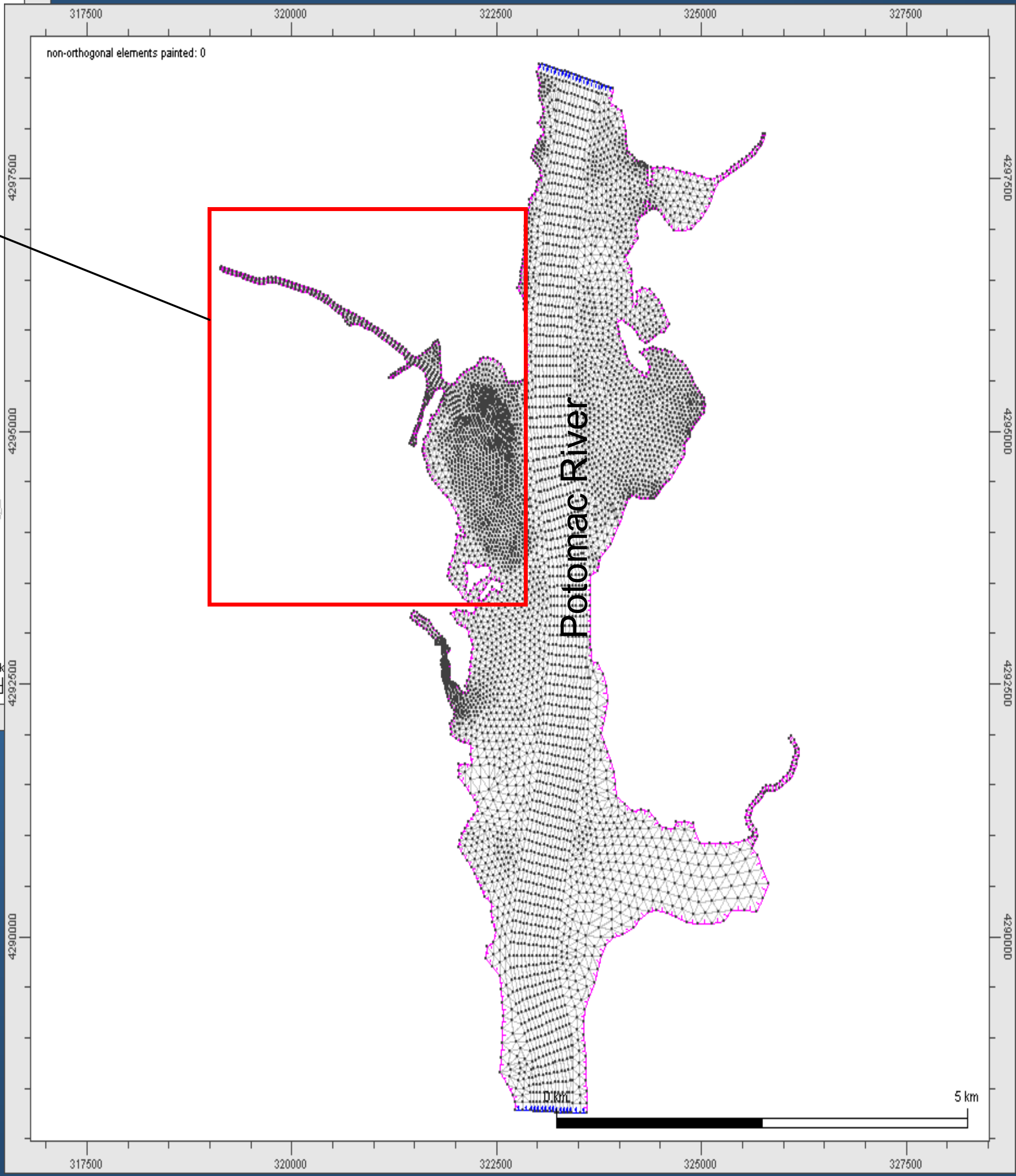
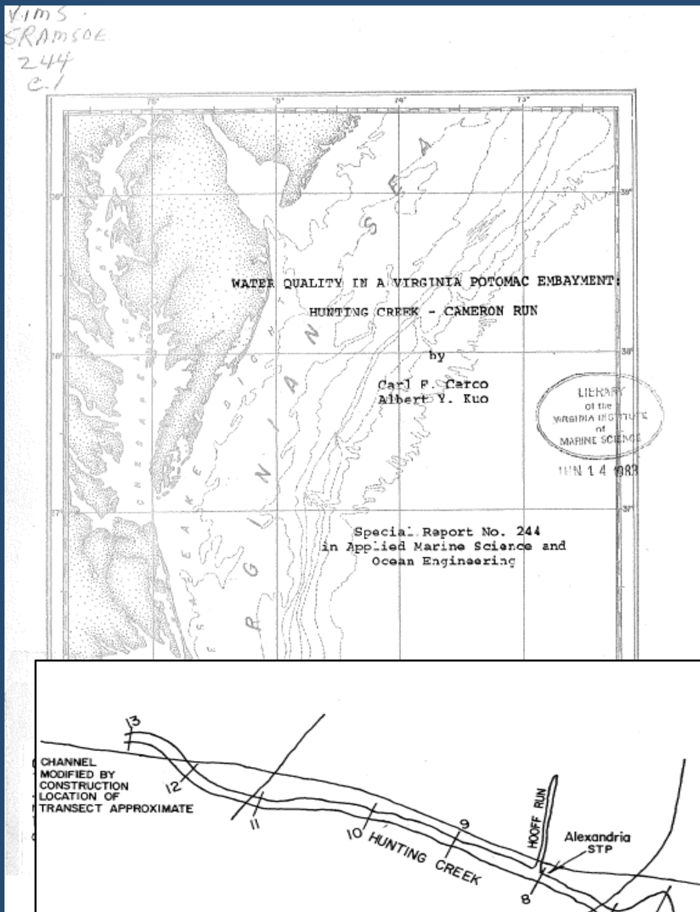

non-orthogonal elements painted: 0
Potomac River
317500
320000
322500
325000
327500
4297500
4295000
4292500
4290000
5 km

VIMS Historical Data



VIMS
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WATER QUALITY IN A VIRGINIA POTOMAC EMBAYMENT:
HUNTING CREEK - CAMERON RUN

by

Carl F. Cerco
Albert Y. Kuo

Special Report No. 244
in Applied Marine Science and
Ocean Engineering

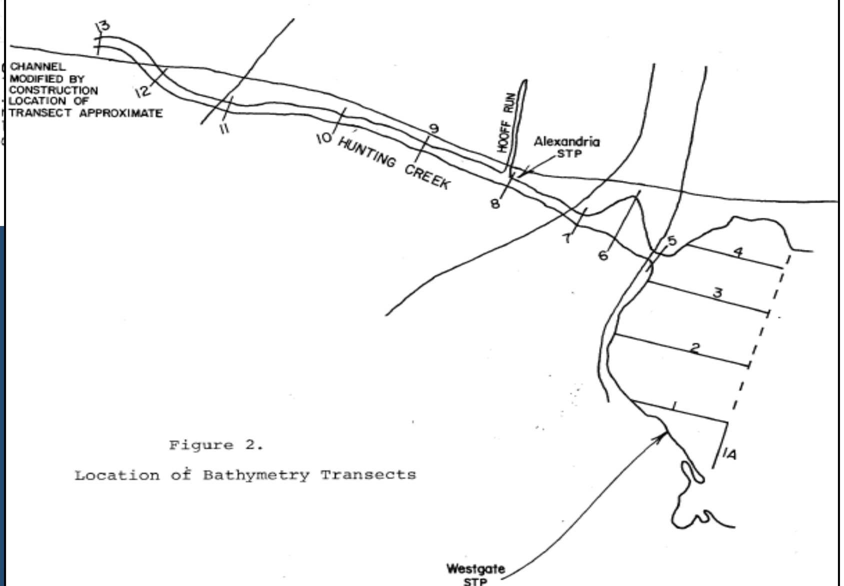


Figure 2.
Location of Bathymetry Transects

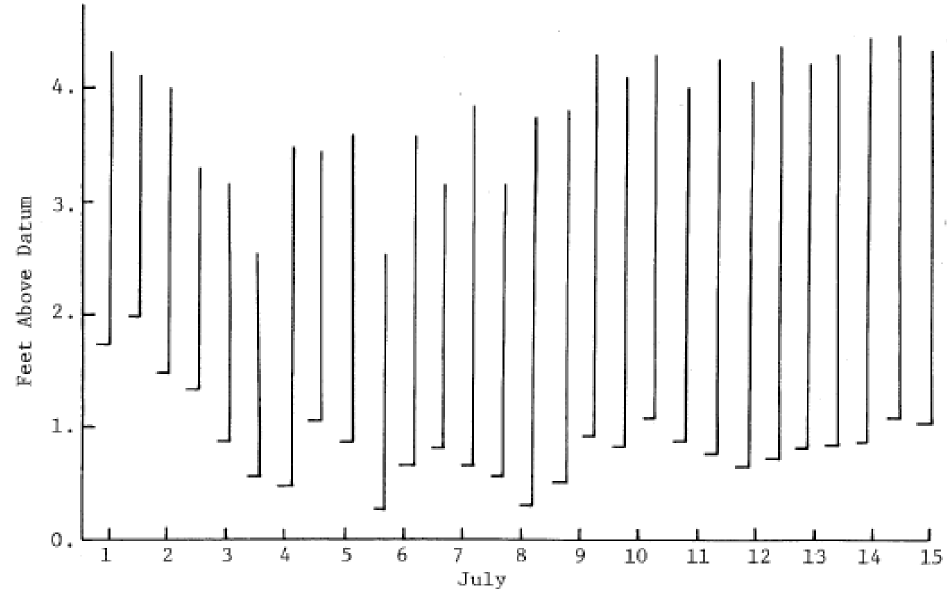


Figure 3. Tide range at mouth of Hunting Creek, July 1-15, 1979.

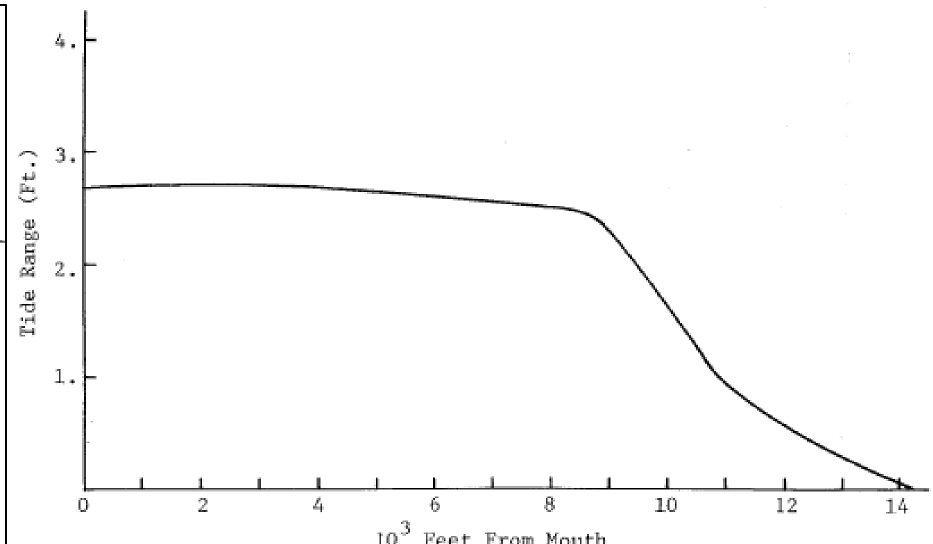
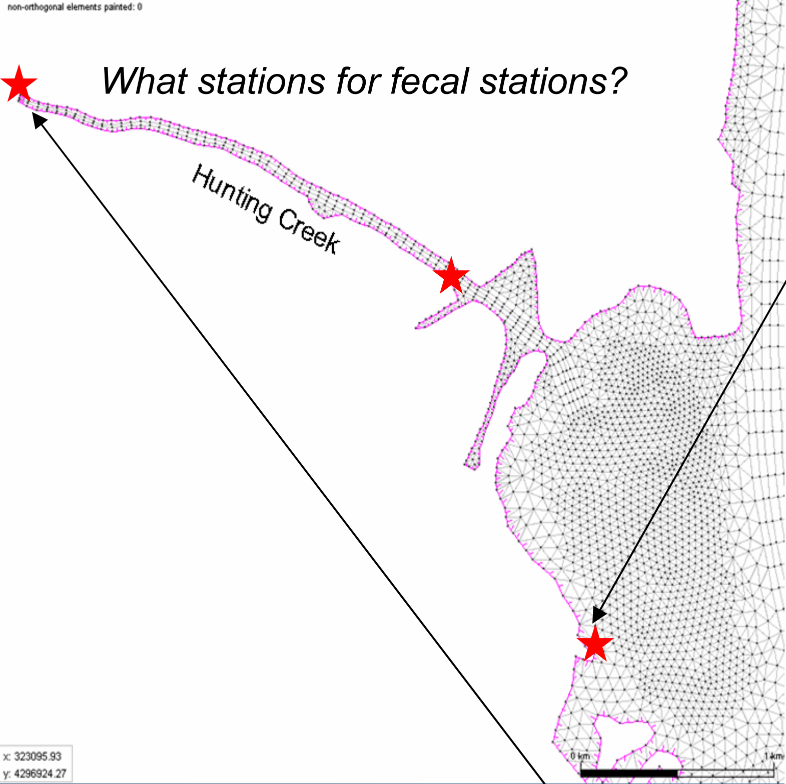
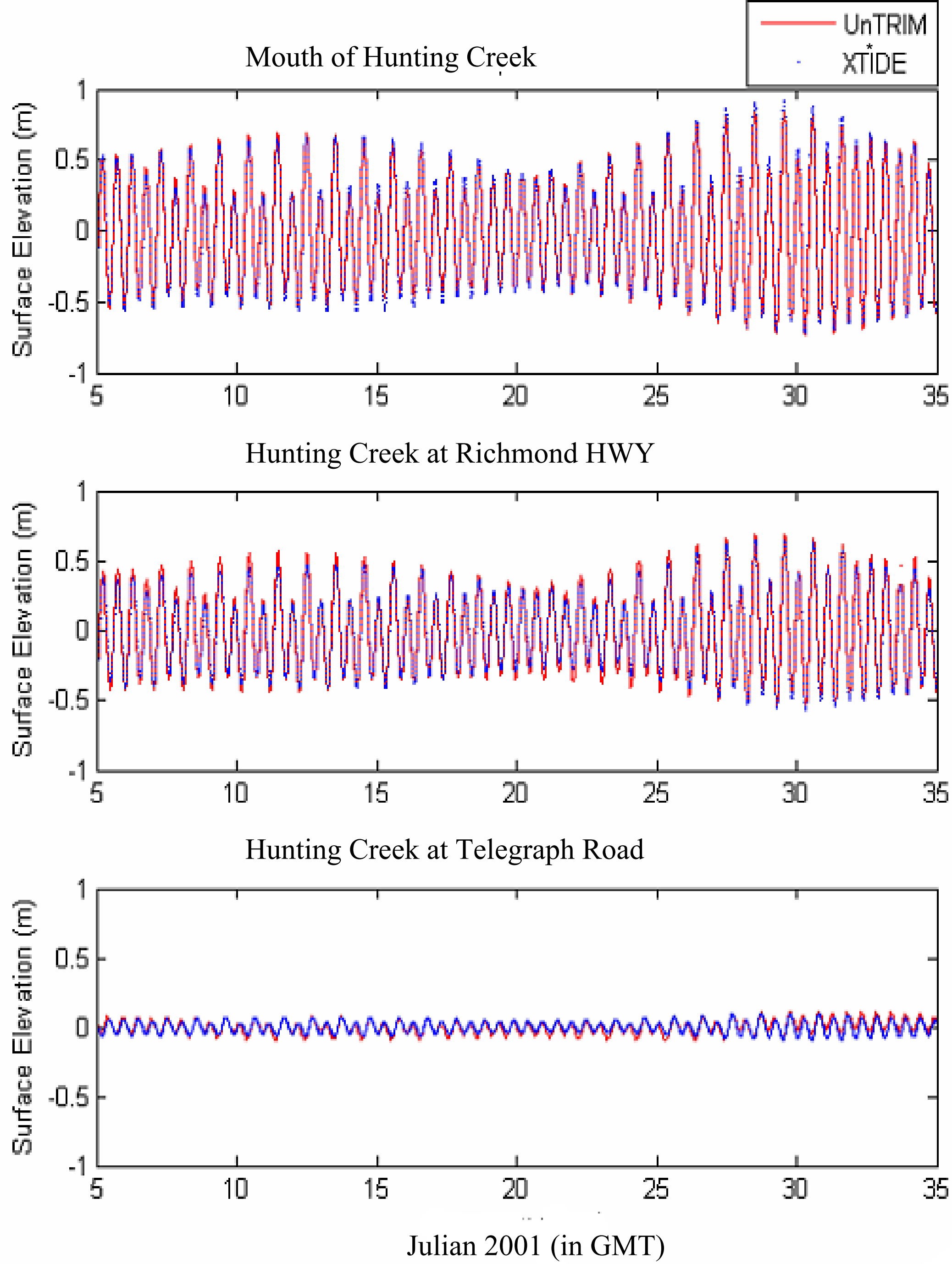


Figure 4. Tide range in Hunting Creek, July 31 - Aug. 1, 1979.

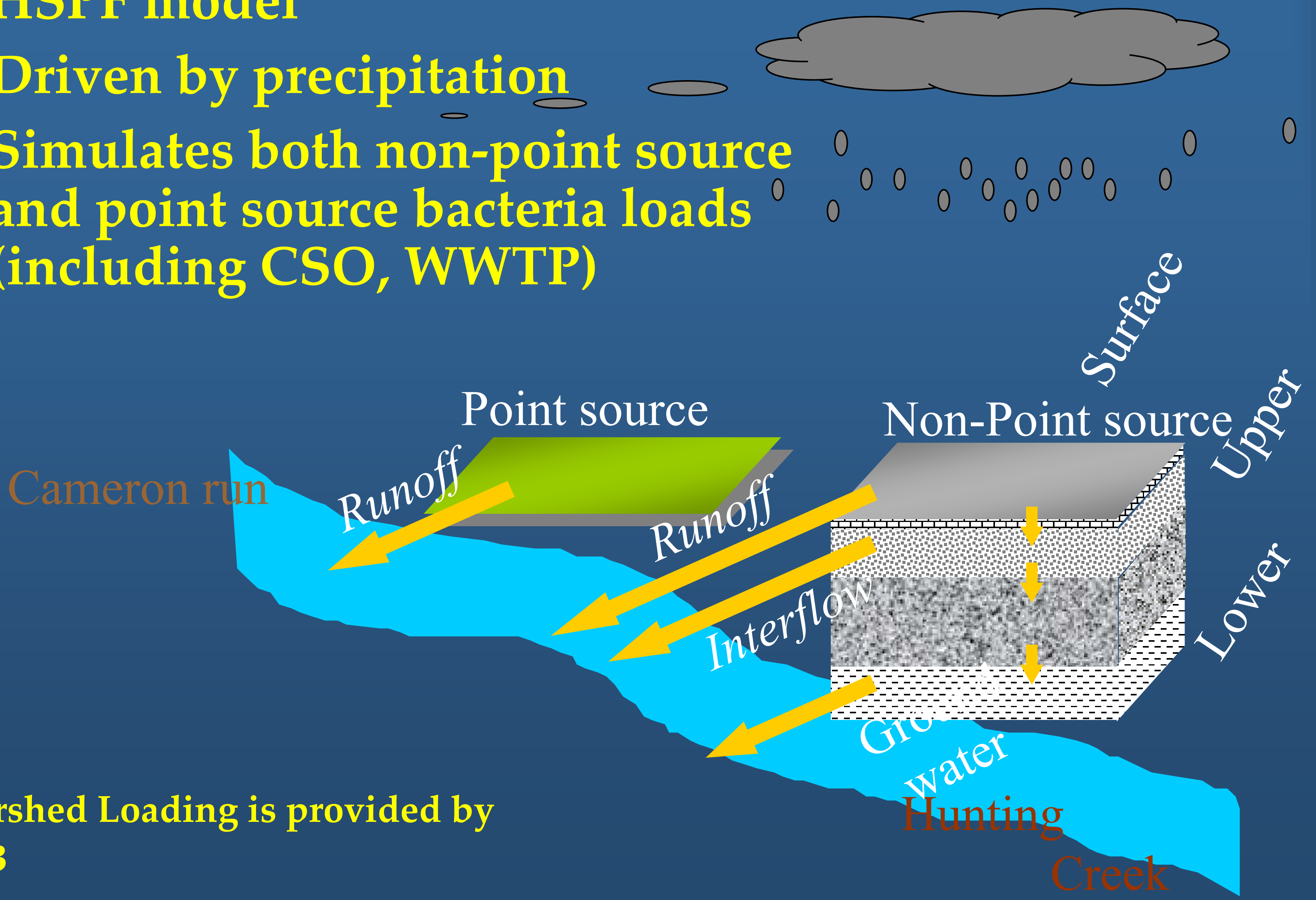




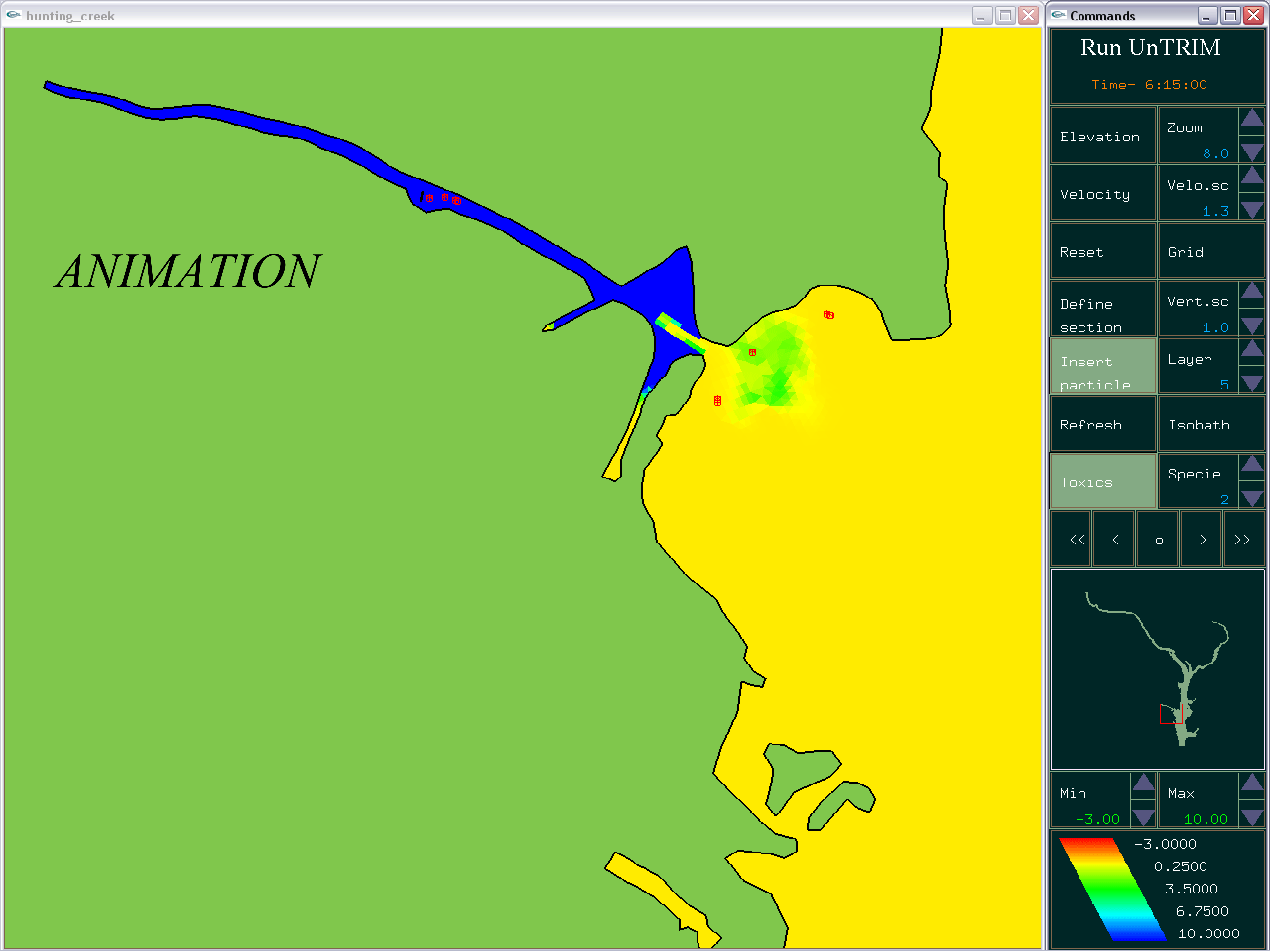
*XTIDE is a harmonic tide predictor for X windows see http://www.flaterco.com/xtide/

Derive Bacteria Loading from Watershed Model

- **HSPF model**
- **Driven by precipitation**
- **Simulates both non-point source and point source bacteria loads (including CSO, WWTP)**



- **Watershed Loading is provided by ICPRB**


hunting_creek
ANIMATION
Commands
Run UnTRIM
Time= 6:15:00
Elevation
Zoom
8.0
Velocity
Velo.sc
1.3
Reset
Grid
Define section
Vert.sc
1.0
Insert particle
Layer
5
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Specie
2
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o
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Min
-3.00
Max
10.00
-3.0000
0.2500
3.5000
6.7500
10.0000

Future Work

- Additional hydrodynamic model calibration with historical dye dispersion data
- Further verifying non-point and point source loading inputs
- Compare fecal coliform modeled concentration with monitoring data
- Conduct 2001-2005 long-term simulation

Comment Period

Comment Period for Materials Presented at the TAC Meeting:

- June 30, 2009 to July 30, 2009
- Comments should be submitted in writing to:
  Katie Conaway
  Katie.Conaway@deq.virginia.gov
  13901 Crown Court, Woodbridge, VA 22193

Project Tasks and Milestones

Hunting Creek/Cameron Run/Holmes Run Bacteria TMDL Studies	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10
Data Gathering	■	■	■	■	■											
TAC Meeting #1			■													
Public Meeting #1			■													
ELCIRC Model Setup			■	■	■											
HSPF Setup/Calibration			■	■	■											
TAC Meeting #2						■										
ELCIRC Model Calibration						■	■	■	■							
TAC Meeting #3										■						
Develop TMDL Scenarios										■	■	■	■			
TAC Meeting #4													■			
Prepare TMDL Reports													■	■		
Public Meeting #2														■		
Draft TMDL for Review															■	
Submit Draft Report to EPA																■

**Dates are subject to change. TAC Meetings can be added or removed, depending on project needs.*

CONTACTS

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Department of Physical Sciences
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Phone: (804) 684-7215
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